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PROCESSING VEGETABLE RESEARCH REPORT 1994

Mark Bennett
Elaine Grassbaugh
Ken Scaife
Mark Schmittgen
Dept. of Horticulture and Crop Science
Columbus, OH

The Ohio State University
Ohio Agricultural Research and Development Center

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INTRODUCTION

This report summarizes the results of several processing vegetable studies conducted during 1994. Weather data for the '94 growing season are included at the end of this report. Adequate rainfall and cooler than normal temperatures during July - early September led to very good vegetable crop yields in these field studies.

The excellent cooperation of branch/farm managers Ken Scaife and Mark Schmittgen, Sean Mueller, Ken DeWeese; former grad student Nancy Creamer (now Assistant Professor, N.C. State University); Winston Bash and Gary Wenneker, OSU Pilot Plant; and many others is appreciated. We hope that this type of information is of benefit to the processing vegetable industry in Ohio and the Great Lakes region. Your comments and suggestions for future efforts are always welcome.

Mark Bennett
Dept. of Horticulture and Crop Science
The Ohio State University
2001 Fyffe Court
Columbus, OH 43210
phone: (614) 292-3864
FAX: (614) 292-3505
e-mail: mbennett@magnus.acs.ohio-state.edu

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SEEDLING ESTABLISHMENT, YIELD, AND QUALITY OF PROCESSING TOMATOES

Principle Investigator: MARK A. BENNETT

Other Key Personnel: ELAINE GRASSBAUGH - Research Associate
KEN SCAIFE - OARDC Veg. Crops Branch Mgr. (Fremont)

Objective(s) of Research :

(1) Compare processing tomato canopy development, fruit set, fruit size and yields using a range of single and twin-row plant populations (6,000 - 18,000 plants/A)

(2) Evaluate the potential of DCPTA [2-(3,4-dichlorophenoxy) triethylamine] to increase tomato yields and solids.

Planned Scope of Research:

(1) Midwestern tomato producers have indicated interest in cutting crop establishment costs by reducing plant stands. Data from Ohio in the 1970's and early 1980's show some potential for this practice, but little work on lower plant populations exists for plug plants, or for currently important cultivars. Single and twin-row transplant spacings giving 6,000, 9,000, 12,000, 15,000, and 18,000 plants/acre were compared in replicated field studies using 3 current cultivars ('OH8245', 'H9036', and 'PS696') with differing vine types. An early variety ('H7135') was studied in an observational (1 rep) experiment.

(2) Application of DCPTA as a (1) pregermination seed treatment and (2) foliar spray to young plants was again evaluated in field tests. Brix values were increased 5-7% by DCPTA treatments in 1993. More cultivars should be evaluated using this bioregulator, which should also improve fruit color.

Materials and Methods:

(1) **1994 PROCESSING TOMATO PLANT POPULATION STUDY**

Cvs.	Trt #	Row	Population/A	Plant Spacing within the row (inches)
H9036, OH8245,	1	single	6,000	17
P696, H7135	2	single	9,000	11
	3	single	12,000	8.5
	4	single	15,000	7
	5	single	18,000	5.5
	6	double	6,000	34
	7	double	9,000	22
	8	double	12,000	17
	9	double	15,000	14
	10	double	18,000	11

Rows: 30 feet long
Rows spaced on 5' centers
Transplanted to Veg. Crops Branch (VCB) on 5/19/94

(2) **1994 DCPTA APPLICATIONS ON PROCESSING TOMATOES**

Trt #	Cv.	Treatment
1	'H7145'	DCPTA/Seed Treatment
2	"	Tween Control
3	"	DCPTA/Foliar Spray
4	"	Control

Rows: 30 feet long
Rows spaced on 5' centers
Transplanted at the VCB on 5/19/94

Results and Discussion:

PLANT POPULATION STUDY - Plant spacing had a significant effect in 1994 on fruit yields and percent red fruit of 'OH8245' (Table 1). Best 'OH8245' yields were achieved at twin-row spacings of 12,000 to 18,000 plants/A, and yield patterns were quite different from those observed in 1993 (Figure 1).

Yields of 'H9036' were not significantly affected by plant population or spacing in 1994, but 12,000 plants/A tended to give top yields for either single or twin-row systems (Table 1). A comparison of 'H9036' red fruit yields for 1993 and 1994 is found in Figure 2. New entries in the 1994 study were 'P696' (replicated) and an observational experiment using the early variety 'H7135' (Table 2). Fruit yields of 'P696' were not statistically affected by spacing or population, although top yields tended to appear at the 12,000 plants/A (single row) and 18,000 plants/A (twin-row) levels for this large-vined cultivar (Figure 3). Due to scheduling difficulties, 'P696' was harvested at a lower percent red fruit stage (77-81%) than the other cultivars, and actual yield potential is reflected in the good red and green fruit (T/A) columns (Tables 1,2). The early maturing variety, 'H7135' appears to benefit from minimum plant populations of 12,000 (twin-row) to 15,000 (single row) plants/A, using the preliminary data of 1994 (Table 2, Figure 4). In other measurements, all four varieties responded as expected to increasing plant populations, with linear decreases in average plant fresh weight, fruit number/plant, and total fruit weight/plant (Tables 1,2).

The impact of plant population and processing tomato yields on crop establishment costs is summarized in Table 3.

As has been reported for wheat (Turner, et al, 1994) and other crops, the optimum planting density for processing tomatoes grown in the midwestern U.S. varies with season, location, cultivar, etc. Rains were timely during the 1994 growing season at Fremont, Ohio and temperatures were moderate during fruit set and sizing (Table 4). Red fruit yields were considerably higher in 1994 for the two cultivars compared over two seasons, 'H9036' (up an average 10 T/A) and 'OH8245' (up 13 T/A), even though percent red fruit at harvest was higher for 1993 studies.

1994 DCPTA FIELD STUDY - DCPTA is a naturally-occurring bioregulator which has increased tomato solids in California and Ohio research. Application of DCPTA [2-(3,4-dichlorophenoxy)triethylamine] was made as a (1) pregermination seed soak, and (2) foliar spray to young tomato plants. This compound had no effect on 'H7145' fruit yields or quality in 1994 (Table 5). More study using DCPTA in the midwest U.S. is needed, and additional cultivars should be included.

Table 1. Processing Tomato Plant Population/Spacing Study – 1994; Fremont, OH.

Cultivar	Row	Plant Population/A	Red T/A	Green T/A	Red & Green T/A	Rot T/A	% Red	Avg. # Red Fruit/Plant	Avg. Red Fruit Wt (lbs)	Avg. Wt of Red Fruit/ Plant (lbs)	Avg. # Green Fruit/Plant	Avg. Green Fruit Wt (lbs)	Avg. Wt of Green Fruit/ Plant (lbs)	Plant Fresh Wt (gm)
'OH8245'	Single	6,000	37.2	7.8	45.0	0.9	81	110	.14	15.5	32	.09	2.8	900
″	Single	9,000	40.0	5.7	45.7	1.5	85	77	.13	9.8	23	.07	1.5	689
″	Single	12,000	41.2	6.3	47.5	1.0	85	58	.13	7.5	13	.08	1.0	439
″	Single	15,000	37.6	7.2	44.8	1.6	81	56	.13	7.0	11	.08	0.8	492
″	Single	18,000	40.4	7.6	48.0	1.7	81	47	.12	5.7	12	.07	0.9	409
″	Double	6,000	36.1	5.2	41.3	1.4	84	96	.13	12.4	16	.08	1.3	757
″	Double	9,000	40.2	5.4	45.6	2.0	84	79	.13	10.2	14	.07	1.1	643
″	Double	12,000	46.1	6.4	52.5	1.9	85	79	.14	10.8	17	.08	1.3	689
″	Double	15,000	44.9	5.1	50.0	1.9	86	60	.13	7.6	17	.08	1.4	560
″	Double	18,000	45.9	5.9	51.8	1.8	86	48	.11	5.3	23	.05	1.2	477
LSD (0.05)			5.17	NS	6.00	0.70	0.03	20.3	NS	2.51	NS	NS	NS	233.8
p value				0.117					0.405		0.304	0.076	0.119	
C.V.				22.3					9.9		58.9	20.2	59.4	
'H9036'	Single	6,000	47.2	4.5	51.7	2.9	86	131	.15	19.0	26	.06	1.6	953
″	Single	9,000	50.7	6.9	57.6	3.2	83	104	.15	15.4	23	.07	1.6	840
″	Single	12,000	54.4	5.2	59.6	3.1	87	71	.16	11.6	12	.08	1.0	454
″	Single	15,000	45.7	5.0	50.7	3.2	85	48	.14	6.7	10	.07	0.8	295
″	Single	18,000	52.4	5.0	57.4	3.3	86	56	.13	7.4	14	.07	0.9	393
″	Double	6,000	45.7	4.8	50.5	2.9	86	99	.17	16.7	28	.06	1.8	863
″	Double	9,000	47.4	4.1	51.5	2.6	87	87	.14	11.7	8	.05	0.5	507
″	Double	12,000	49.2	5.8	55.0	3.3	84	76	.13	10.0	13	.07	0.9	567
″	Double	15,000	49.7	5.4	55.1	3.3	85	68	.13	8.6	10	.05	0.5	409
″	Double	18,000	44.7	4.2	48.9	3.8	85	51	.14	7.0	7	.06	0.5	363
LSD (0.05)			NS	NS	NS	NS	NS	21.94	NS	3.53	NS	NS	NS	199.3
p value			0.053	0.759	0.072	0.858	0.728		0.376		0.066	0.482	0.125	
C.V.			8.7	32.8	9.2	22.6	2.9		16.6		69.0	25.3	69.4	

Table 2. Processing Tomato Plant Population/Spacing Study – 1994; Fremont, OH.

Cultivar	Row	Plant Population/A	Red T/A	Green T/A	Red & Green T/A	Rot T/A	% Red	Avg. # Red Fruit/Plant	Avg. Red Fruit Wt(lbs)	Avg. Wt of Red Fruit/ Plant(lbs)	Avg. # Green Fruit/Plant	Avg. Green Fruit Wt (lbs)	Avg. Wt of Green Fruit/ Plant (lbs)	Plant Fresh Wt (gm)
'P696'	Single	6,000	40.5	10.0	50.5	1.6	78	117	.13	15.0	42	.07	2.9	1226
"	Single	9,000	43.8	9.4	53.2	1.8	80	82	.12	10.1	33	.08	2.7	885
"	Single	12,000	46.8	10.6	57.4	1.6	79	75	.12	9.0	35	.07	2.6	878
"	Single	15,000	44.4	9.8	54.2	1.9	79	65	.12	8.1	25	.08	2.0	382
"	Single	18,000	44.9	8.8	53.7	2.2	81	48	.12	5.8	16	.07	1.3	499
"	Double	6,000	41.3	10.7	52.0	1.2	77	109	.13	13.7	58	.07	3.8	1021
"	Double	9,000	33.4	10.2	49.6	1.7	77	68	.12	8.3	26	.07	1.9	779
"	Double	12,000	42.9	11.4	54.3	1.5	77	87	.12	10.2	31	.07	2.2	923
"	Double	15,000	43.8	8.4	52.2	1.7	81	55	.12	6.8	20	.08	1.4	620
"	Double	18,000	46.1	12.2	58.3	1.6	77	53	.11	6.1	14	.08	1.2	552
LSD (0.05)			NS	NS	NS	NS	NS	24.8	NS	3.18	NS	NS	NS	360.6
p value			0.246	0.904	0.447	0.590	0.963		0.770		0.134	0.882	0.204	
C.V.			8.5	27.3	8.8	29.6	5.5		8.1		62.7	12.4	55.7	
'H7135'	Single	6,000	11.6	1.9	13.5	0.5	83	116	.12	13.4	30	.04	1.1	863
"	Single	9,000	14.0	1.6	15.6	0.5	87	73	.11	8.2	16	.04	0.6	477
"	Single	12,000	26.9	2.0	28.9	0.2	93	67	.11	7.3	15	.05	0.7	409
"	Single	15,000	33.0	2.3	35.3	0.3	93	63	.11	6.7	14	.05	0.7	431
"	Single	18,000	29.1	1.4	30.5	0.2	95	28	.10	2.7	4	.05	0.2	182
"	Double	6,000	22.6	1.4	24.0	0.4	93	69	.11	7.5	22	.03	0.7	454
"	Double	9,000	27.0	1.4	28.4	1.0	92	86	.10	8.8	19	.02	0.4	477
"	Double	12,000	33.5	1.8	35.3	1.2	92	77	.11	8.5	24	.04	1.0	590
"	Double	15,000	34.0	1.5	35.5	0.8	94	67	.10	6.6	12	.03	0.4	409
"	Double	18,000	33.7	1.6	35.3	0.5	94	45	.07	4.7	8	.05	0.4	295

Table 3. Cost/Benefit estimates for tomato transplants per acre and red fruit yields, 1994; Fremont, OH. Calculations assume a cost of $20 per 1000 transplants.

	Transplant dollars ($) per ton of good red fruit							
	'O8245'		'H9036'		'P696'		'H7135'	
Plant Pop. (1000's)	single	dbl. row	single	dbl. row	single	dbl. row	single	dbl. row
6	3.23	3.32	2.54	2.63	2.96	2.91	10.34	5.31
9	4.50	4.48	3.55	3.77	4.10	4.57	12.86	6.67
12	5.82	5.21	4.41	4.87	5.13	5.59	8.92	7.16
15	7.98	6.68	6.56	6.04	6.76	6.85	9.09	8.82
18	8.91	7.84	6.87	8.05	8.02	7.81	12.37	10.68

Table 4. Environmental factors (rainfall, temperature, irrigations) at the Vegetable Crops Branch 1994 – OSU/OARDC; Fremont, OH.

	Rainfall (in.)		Irrigation (in.)		Total (in.)		Temperature (F) --------1994---------		
	1993	1994	1993	1994	1993	1994	Min.	Max.	Avg.
May 19-31 ('94)		.5		1.0		1.5	36	87	63.5
May 27-31 ('93)	0.5		-		0.5				
June	4.3	4.1	-	-	4.3	4.1	38	97	69.8
July	1.5	1.9	1.2	-	2.7	1.9	49	93	72.1
August	0.7	2.5	1.0	-	1.7	2.5	43	88	66.5
Sept. 1-8	0.8	0	-	-	0.8	-	40	82	59.3
	7.8	9.0	2.2	1.0	10.0	10.0			

Table 5. Influence of DCPTA on processing tomatoes (cv. 'H7145') – 1994; Fremont, OH.

Treatment	Red T/A	Green T/A	Cull T/A	Avg. red fruit wt (lb)	Plant Fresh Wt (lb)	pH	% Acidity	Brix	Agtron
DCPTA/seed soak	43.6	4.9	2.2	.12	.84	4.0	0.256	2.9	55.0
Tween Control	43.3	3.7	2.5	.10	.91	4.1	0.248	2.8	53.6
DCPTA/foliar spray	43.1	4.5	2.7	.12	.96	4.0	0.266	2.7	55.0
Control	42.1	4.5	2.1	.12	.83	4.0	0.256	3.0	56.2
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
p value	.85	.54	.13	.35	.62	.45	.69	.16	.87
CV	5.7	27.3	15.2	17.4	18.2	3.7	8.2	6.1	7.9

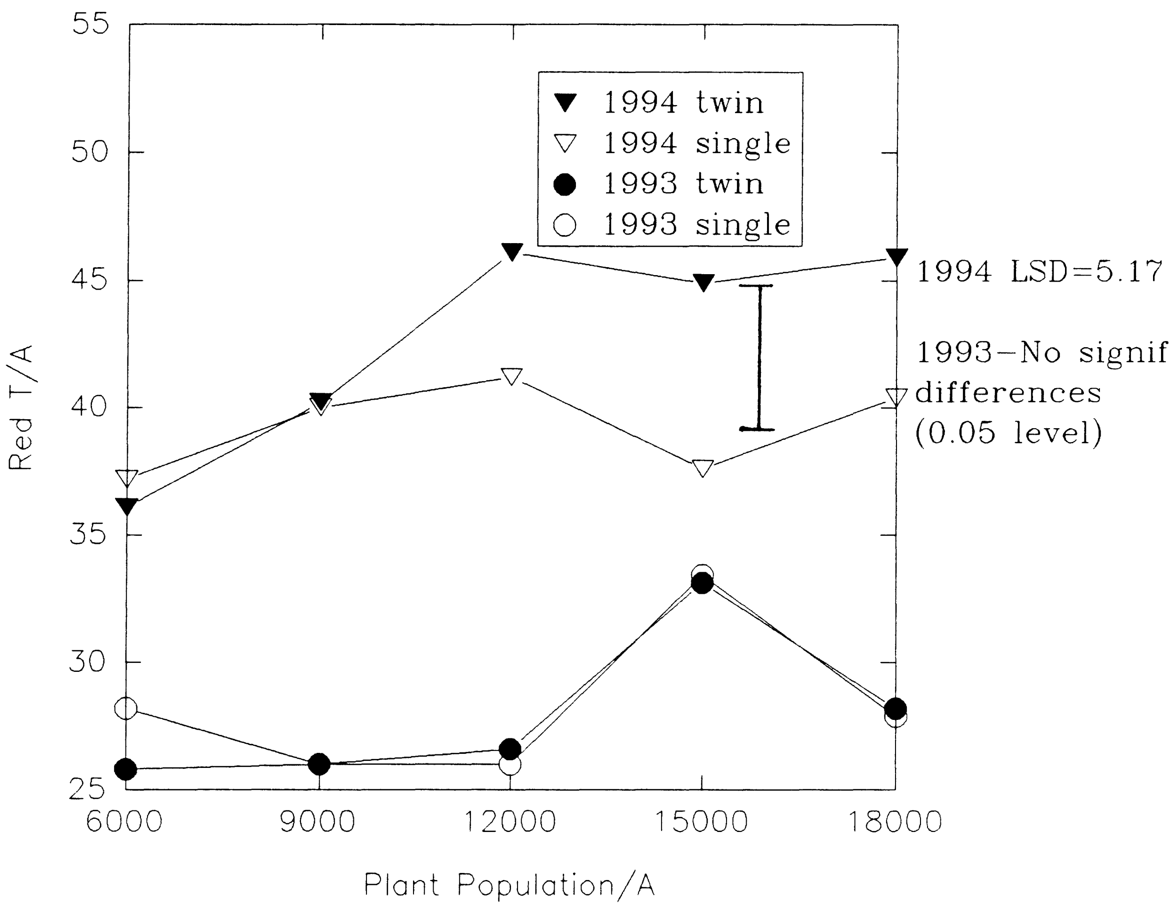


Figure 1. Relationship of processing tomato plant spacing and red fruit yield for 'OH8245', Fremont, OH, 1993 and 1994.

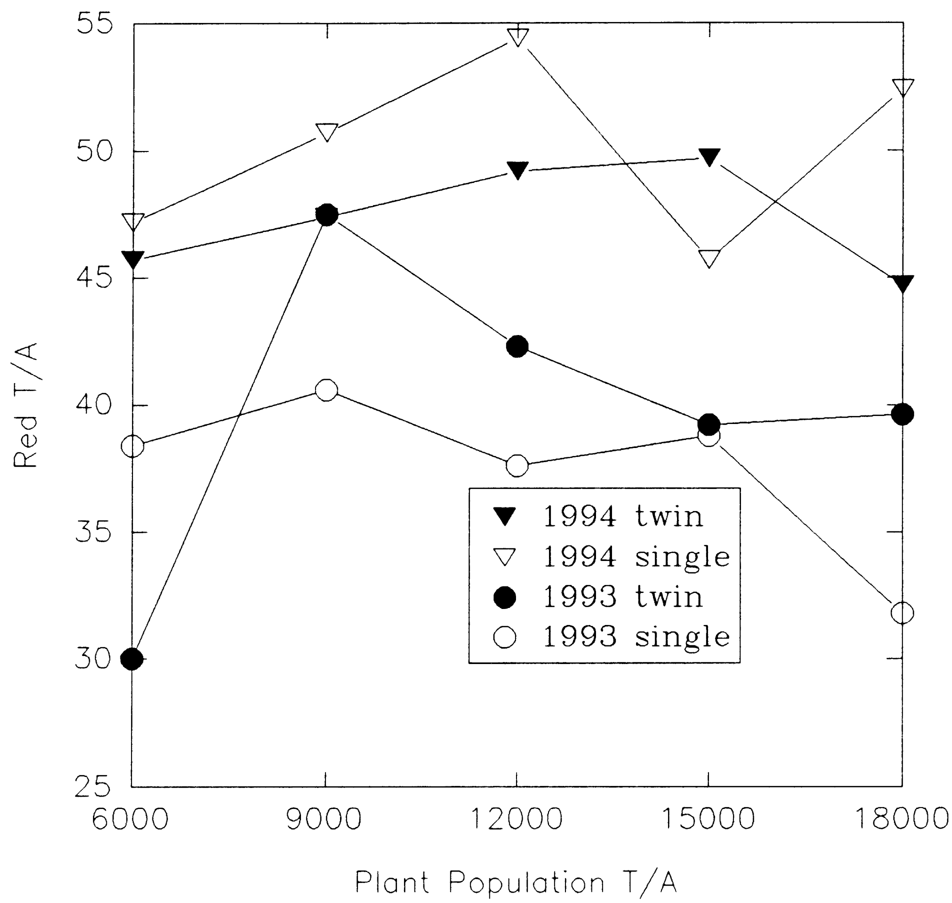


Figure 2. Relationship of processing tomato plant spacing and red fruit yield for 'H9036', Fremont, OH, 1993 and 1994 – no significant differences (0.05 level).

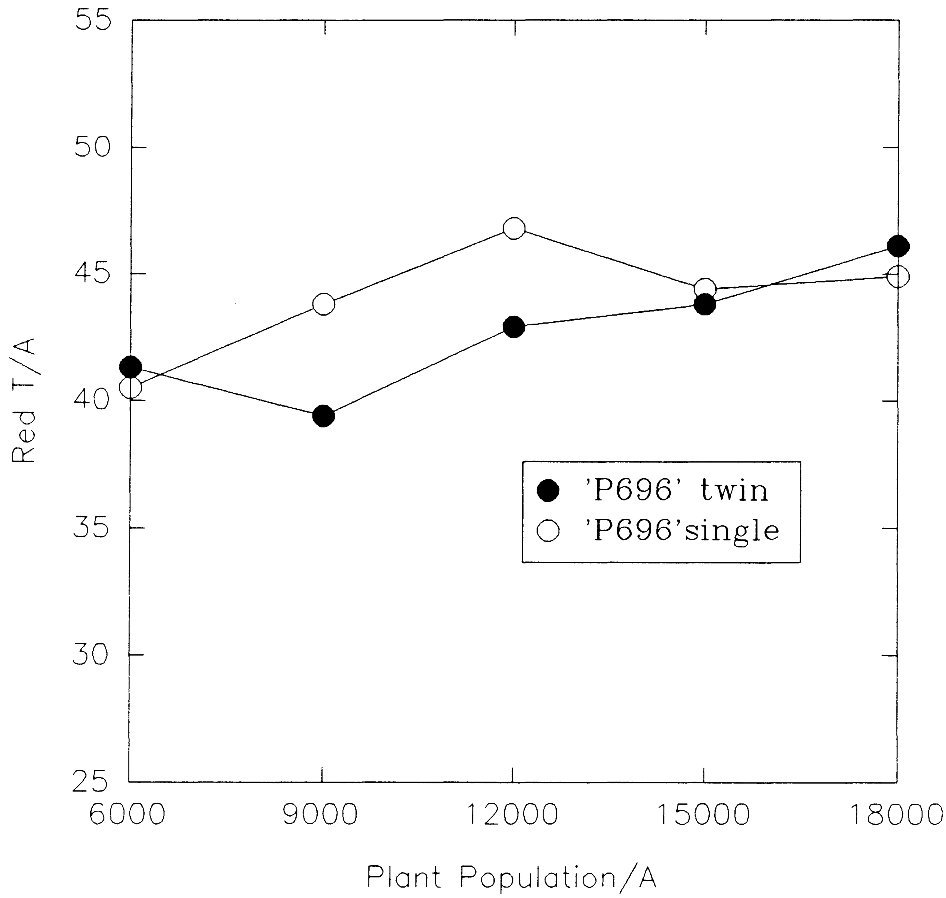


Figure 3. Relationship of processing tomato plant spacing and red fruit yield for 'P696', Fremont, OH, 1994 – no significant differences (0.05 level).

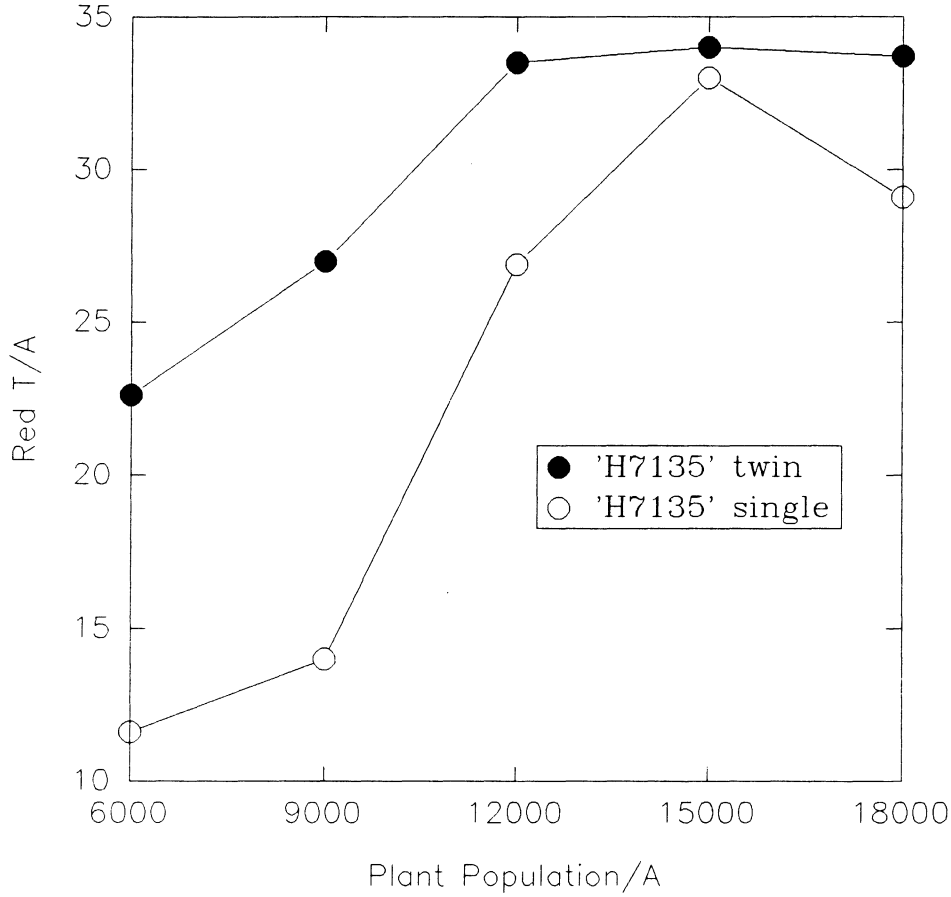


Figure 4. Relationship of processing tomato plant spacing and red fruit yield for 'H7135', Fremont, OH, 1994 (single rep observation).

ACA™ RATE COMPARISONS ON GROWTH, YIELD, AND QUALITY OF PROCESSING TOMATOES

Principal Investigator: MARK BENNETT
Other Key Personnel: ELAINE GRASSBAUGH AND KEN SCAIFE

JUSTIFICATION AND PROCEDURES:

Processing tomato growers and processors in the Great Lakes region are eager for ways to make production of this high-value crop even more efficient. This research repeated the 1993 replicated trial (at Fremont, Ohio) of ACA™ applied at transplanting. Detailed sampling of root data (3-4 weeks post-transplant) was conducted in 1994.

A supplemental study to collect more detailed root observations was conducted in 1994. Processing tomato ('OH8245') plants were excavated at 2, 4, 6, 8, and 10 weeks post-transplanting for comparison of plant dry weights, root dry weights, morphological characteristics, and root:shoot ratios. Final yield of good red, green and culled fruits were noted along with soluble solids and color measurements.

Processing tomatoes (cultivar 'OH8245') were planted in twin-row raised beds 30 feet long. Six different rates of ACA™ were applied at transplant along with starter fertilizer solution. Control beds were also planted using starter fertilizer only. Sampling beds of the control treatment and one ACA™ rate (4 oz/A) were also planted for plant excavation during the growing season.

<u>Treatments</u>:

Starter Fertilizer Only
4 oz/ACA/A + starter fertilizer
8 oz/ACA/A + starter fertilizer
12 oz/ACA/A + starter fertilizer
16 oz/ACA/A + starter fertilizer
20 oz/ACA/A + starter fertilizer
24 oz/ACA/A + starter fertilizer

<u>Treatments for sampling beds</u>:

Starter Fertilizer Only
4 oz/ACA/A + starter fertilizer

Each treatment was replicated 4 times and were transplanted to the field at the Vegetable Crops Branch, Fremont, Ohio on May 19, 1994. Treatment plots were harvested on September 1, 1994 for fruit yield and soluble solids and color determinations.

ACA on Processing Tomatoes - 1994

Cultivar: 'OH8245'

Treatment	Red T/A	Green T/A	Red & Grn. T/A	Cull T/A	Brix	Color*
Starter Fertilizer Only	48.8	6.7	55.6	1.9	3.1	62.6
4 oz. ACA/A + starter fertilizer	45.3	5.0	50.2	2.2	3.4	66.6
8 oz. ACA/A + starter fertilizer	44.7	6.2	51.0	1.8	3.4	61.4
12 oz. ACA/A + starter fertilizer	45.7	6.0	51.7	2.1	3.2	65.1
16 oz. ACA/A + starter fertilizer	43.5	6.2	49.7	2.4	3.3	61.0
20 oz. ACA/A + starter fertilizer	43.9	5.6	49.5	1.9	3.2	68.1
24 oz. ACA/A + starter fertilizer	47.1	5.5	52.6	2.3	3.3	60.7
LSD (0.05)	NS	NS	NS	NS	NS	NS
p value	0.618	0.706	0.575	0.928	0.190	0.333
CV	9.5	25.3	9.2	38.0	4.5	8.5

* color determined by Agtron model E-5M

ACA Root and Shoot Sampling - 1994
2, 4, 6, 8, and 10 weeks after transplant (cv: 'OH8245')

	----2 wks. after transplant----			----4 wks. after transplant----			----6 wks. after transplant----		
Treatment	Plant Dry Wt.(g)	Root Dry Wt.(g)	Shoot:Root Ratio	Plant Dry Wt.(g)	Root Dry Wt.(g)	Shoot:Root Ratio	Plant Dry Wt.(g)	Root Dry Wt.(g)	Shoot:Root Ratio
Starter Fertilizer Only	3.89	0.41	9.5	34.08	3.43	9.9	125.72	11.88	10.6
4 oz ACA/A + starter fertilizer	3.82	0.38	10.2	35.01	3.00	11.7	145.46	14.24	10.4
LSD (0.05)	NS	NS	NS	NS	NS	1.61	NS	NS	NS
p value	0.774	0.515	0.479	0.748	0.081	0.040	0.068	0.138	0.831
CV	7.95	16.15	13.50	11.33	9.03	8.63	9.25	14.85	12.48

	-------8 wks. after transplant-------				------10 wks. after transplant------			
Treatment	Plant Dry Wt.(g)	Root Dry Wt.(g)	Shoot:Root Ratio	Fruit Number	Plant Dry Wt.(g)	Fruit Number	Fruit Wt.(lbs)	Ave. fruit Wt.(lbs)
Starter Fertilizer Only	244.02	15.98	15.3	43.5	340.50	188.5	11.7	0.062
4 oz ACA/A + starter fertilizer	271.50	20.37	13.5	56.4	391.57	220.7	14.4	0.065
LSD (0.05)	NS	NS	NS	9.94	NS	24.69	2.56	NS
p value	0.150	0.057	0.055	0.020	0.168	0.019	0.040	0.498
CV	9.13	14.58	7.64	11.49	12.59	12.80	11.33	8.69

* numbers indicate value for 3 plants

COVER CROP SELECTION AND MANAGEMENT FOR PROCESSING TOMATO PRODUCTION - 1994

Principal Investigators: NANCY CREAMER, North Carolina State University
MARK A. BENNETT, Ohio State University
Other Key Personnel: Elaine Grassbaugh, Ken Scaife, Mark Schmittgen

A cover crop (CC) mixture of rye, barley, hairy vetch and crimson clover were seeded in the fall of 1993 at the Ohio Department of Agriculture (ODA) Demonstration Farm in Reynoldsburg, OH. The cover crop plots were undercut on June 15, 1994 and tomatoes were transplanted through the mulch in twin rows. Plots were established in three replications using the following nitrogen levels: 0 lbs/A (0), 40 lbs/A (Low), 80 lbs/A (Medium), and 120 lbs/A (High). Conventional plots established in three replications were also planted for comparison (Figure 1).

Cover crop biomass samples were taken at planting in a 9" X 12" area and submitted to the Research Extension Analytical Laboratory in Wooster, Ohio for analysis of percent nitrogen and total carbon. Weed pressure was measured on July 26. Plant survival was noted on August 10. On October 14, three plants from each plot were harvested and dry weights recorded.

ABOVE GROUND CC BIOMASS - taken June 15.

%						
Rye	Vetch	Barley	Crimson Clover	Misc. Non-legume	Misc. Dicots	Misc. Monocots
49	22	8	.2	13	4	3.8

CARBON AND NITROGEN ANALYSIS ON CC ABOVE GROUND BIOMASS - 1994

	Total Carbon	Nitrogen	C:N Ratio
Rye	40.87	.78	52.4
Barley	39.18	1.20	32.7
Vetch	37.98	2.22	17.1

Table 1. Impact of supplemental nitrogen (N) levels on above ground weed biomass, tomato transplant survival, and tomato plant dry weights from cover crop mulch and conventional plots Reynoldsburg, OH - 1994.

N level	WEED BIOMASS (9" X 12" area; mostly ragweed) (7/26/94) Dry weight (g)	PLANT SURVIVAL AFTER TRANSPLANT (8/10/94) %	DRY WTS. FOR 3 TOMATO PLANTS (10/14/94) (g)
0	123.7	65	33.16
Low	96.2	68	39.45
Medium	92.0	75	27.94
High	120.5	73	45.15
Conventional	6.8	88	83.34
LSD (0.05)	64.57	NS	NS

Results and Discussion: The severe winter of 1993/1994 forced us to move this study from Fremont to Reynoldsburg, since the cover crop beds at Fremont were reduced to rye only. The CC mixture at Fremont in Fall'93 was seeded later than is recommended, and the legume component was reduced to an occasional hairy vetch plant in the plots.

Based on earlier results of processing tomato production using CC mixtures (see 1993 Research Report to MAFPA, attached) we wished to determine whether supplemental N would increase tomato yields from CC plots to levels seen for conventional plots. Severe weed competition at the ODA Farm location in 1994 prevented us from collecting useful fruit yield and quality data. We intend to follow up on this idea in 1995 using CC plots established at Columbus and Fremont (Figure 2). The cover crops at this point (late Nov. 1994) are well established in Columbus, thanks to timely irrigations. The Fremont study has relatively thin stands due to a very dry September-October 1994, but will provide practical information on managing CC's for tomato production in the midwest U.S.

FIGURE 1. Cover crop selection and management for processing tomato production – 1994, ODA, Reynoldsburg, OH.

Each plot consists of
2 twin rows
10' feet long

Plant spacing w/in each
bed is 12"
CV: 'OH8245'

Nitrogen Levels/A:
0 = 0
low = 40 lb/A N
med. = 80 lb/A N
high = 120 lb/A N

N fertilier analysis:
46-0-0

CC undercut and plants
transplanted on 6/15/94

All plants rec'd 8 oz.
10-52-10 starter fertilizer
at transplant

CC biomass samples were
taken at harvest

Conventional plots (3 reps)
were also planted on 6/15/94

Med. Rep 3
6' buffer
Low Rep 3
6' buffer
High Rep 3
6' buffer
0 Rep 3
6' buffer
Low Rep 2
6' buffer
Med. Rep 2
6' buffer
0 Rep 2
6' buffer
High Rep 2
6' buffer
Med. Rep 1
6' buffer
0 Rep 1
6' buffer
High Rep 1
6' buffer
Low Rep 1
6' buffer

Conventional Rep 3
6' buffer
Conventional Rep 2
6' buffer
Conventional Rep 1
6' buffer

FIGURE 2. Cover crops/tomato production - 1995.

(cover crop seeding done Sept. 12, 1994 at VCB, Fremont and Sept. 14 at the OSU Hort Farm, Columbus)

To be conducted at the VCB, Fremont and OSU Hort Farm, Columbus.

Treatments

1.) Cover crop mixture at the following rates:
  Hairy vetch 20 lbs/A
  Rye 24 lbs/A
  Barley 24 lbs/A
  Crimson clover 10 lbs/A

2.) Rye and hairy vetch only at the following rates:
  Rye 40 lbs/A
  Hairy vetch 25 lbs/A

3.) Hairy vetch only at 40 lbs/A

4.) Rye only at 80 lbs/A

5.) Barley only at 80 lbs/A

6.) Crimson clover only at 20 lbs/A

7.) Weedy check (no cover crops seeded or herbicides applied)

8.) Conventional - no cover crops; herbicide to be applied to beds in the spring of '95

Each treatment will be evaluated for weed pressure (above ground biomass measurements) and also for processing tomato plant and fruit development and yield.

Each of the 8 treatments is planted in 4 replications; with each replication consisting of 3 beds. Each bed measures 30 feet in length, spaced 5 feet apart with 20' alleys. All plots are raised beds.

G 1 1 1 7 7 7 6 6 6 5 5 5 2 2 2 8 8 8 4 4 4 3 3 3 G REP 4

G 6 6 6 8 8 8 1 1 1 2 2 2 4 4 4 3 3 3 5 5 5 7 7 7 G REP 3

G 8 8 8 4 4 4 2 2 2 5 5 5 3 3 3 7 7 7 6 6 6 1 1 1 G REP 2

G 3 3 3 6 6 6 4 4 4 1 1 1 5 5 5 7 7 7 2 2 2 8 8 8 G REP 1

Title: Cover Crop Management for Vegetable Production Systems.

Principle Investigators: Nancy G. Creamer, and Mark A. Bennett, Department of Horticulture, The Ohio State University.

OBJECTIVES

The research objectives of this two-year study were to (1) evaluate the suitability of various cover crop mixtures for processing tomato production, (2) determine the nitrogen contribution of the cover crop mix (3) determine cover crop impact on weeds, and the role of allelopathy in weed suppression, (4) determine cover crop impact on diseases, and insects, (5) evaluate growth, development, and yield of tomatoes planted into a killed cover crop mulch, and (6) conduct an economic analysis of the production system.

METHODS

In 1991/1992, 13 mixtures of cover crops were evaluated at several locations throughout Ohio. Mixtures of cover crops were examined vs. single species as it is hypothesized that polycultures of several species may be the best way to optimize some of the benefits associated with cover crop use (e.g. nitrogen cycling and weed control potential).

Based on field screening in Ohio (data not shown), the cover crop mixture selected for use in this experiment was hairy vetch (*Vicia villosa*), rye (*Secale cereale*), crimson clover (*Trifolium incarnatum*) and barley (*Hordeum vulgare*).

The design was a randomized complete block with four replications and four treatment. The four treatments represented different management systems which are briefly described below:

1. Conventional Production: Represents typical Ohio production without the use of cover crops. Raised beds were formed in late May. Preplant herbicides were applied (Trifluralin 4EC in Columbus, and Trifluralin and Sencor DF in Fremont), as well as a preplant fertilizer application of 70-140-140 lb/ac N-P-K. Insecticides were used as necessary, based on field scouting (Sevin was applied once in Fremont). Fungicides were applied based on the TOMCAST disease forecasting system which takes into account daily moisture and temperature readings. 5 fungicide applications were necessary in Columbus and 7 in Fremont (Champion, Bravo, and Kocide).

2. Integrated Production (with cover crop): Post-emergent herbicides were to be applied if necessary. Pre-plant fertilizer was applied at half the conventional rate (35-70-70-lb/ac). Insecticides were applied based on scouting (Sevin was applied once in Fremont). Fungicides were applied based on TOMCAST, but at half the recommended rate (5 applications in Fremont, 7 applications in Columbus)

3. Organic Production (with cover crop): Based on Ohio Ecological Food and Farming Association Organic Production Standards. Mechanical weed control was to be used if necessary. For fertility, 3 foliar applications of fish extract (analysis 12-.25-1) were applied once every two weeks for the first 6 weeks of production. Seaweed powder (1-0-3) was combined with the fish for the last application. Insect control was based on scouting (*Bacillus thuringiensis* (B.t.) was applied once in Fremont). No fungicides were applied.

4. No Additional Inputs (with cover crop). This system was designed to determine how well the cover crop could control weeds and provide nutrients for the tomato crop with no additional inputs. After transplanting the tomatoes, there was no additional management.

For the three treatments which had cover crops, the mixture of rye, barley (each seeded @ 24 lb/ac) hairy vetch (seeded @ 20.0 lb/ac), and crimson clover (seeded @ 10.0 lb/ac) was planted on raised beds (5 ft wide by 50 ft long) on Sept. 2, 1992 in Columbus, and on August 25, 1992 in Fremont. Seed was broadcast by hand on the surface of the beds, and lightly raked in.

On May 26 in Columbus, and June 1 in Fremont, the cover crop mixture was mechanically killed with an undercutter and left on the surface as a mulch. The undercutter was designed by Dr. Randall Wood and a student, Barry Plassman, and built by the Agriculture Engineering Dept. at OSU. On the same day, processing tomatoes ('OH 8245') were transplanted into the mulch. An RJ Equipment (Blenheim, Ontario) no-till transplanter was used for the transplanting, and was able to successfully cut slots in the 4-6 in thick mulch. Twin rows were planted 16 in apart, and within-row spacing was approximately 15 in.

Measurements

The following measurements were made: Above-ground biomass and % nitrogen in the above-ground biomass; soil moistures, temperatures, and nitrate levels; impact on weeds, insects, and diseases; and, tomato growth development, and yield.

RESULTS (see attached graphs)

CONCLUSIONS

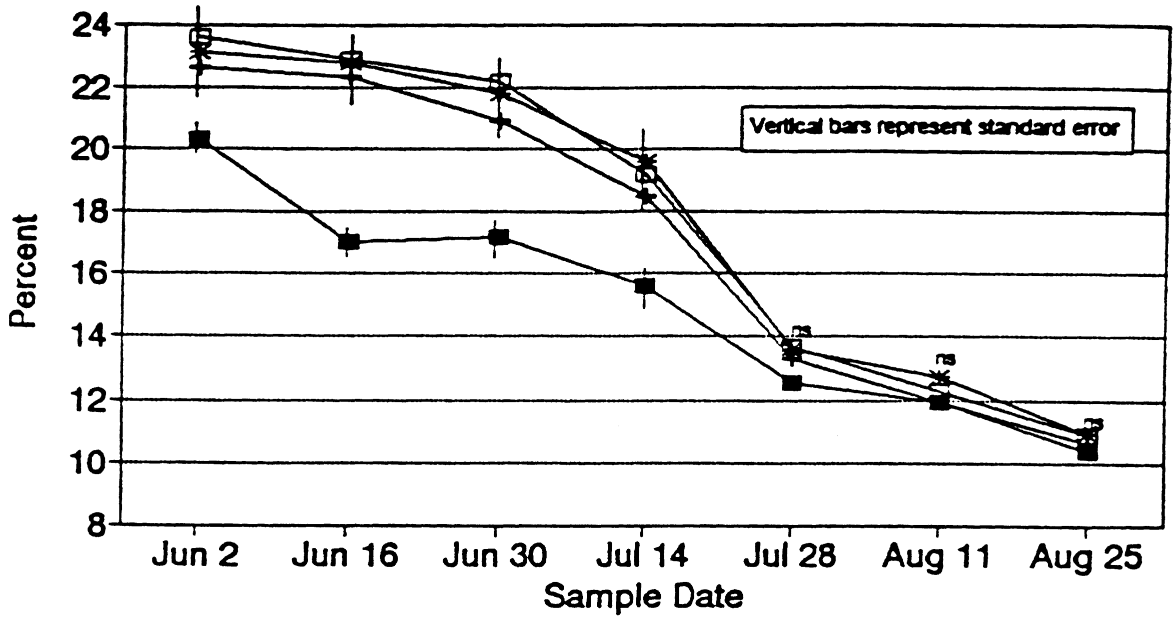
Cover crops can be managed in various ways in crop production systems. This method of undercutting the cover crop, leaving the residue intact on the soil surface as a mulch, has several potential benefits. The cover crop residue was able to suppress annual broadleaf and grass weeds in this experiment as successfully as the herbicide did. Organic vegetable growers generally view weed management as the biggest problem they face, and this system may be at least a partial answer to their problem. Greenhouse and field studies are being conducted to determine if the weed suppression was due to physical or allelochemical factors, or some combination effect.

In general, the tomatoes planted into the mulch looked vigorous throughout the growing season (Figure 11). Because of this, we did not add additional nitrogen to the organic system. Additional N would have most likely have increased the yield of those plots.

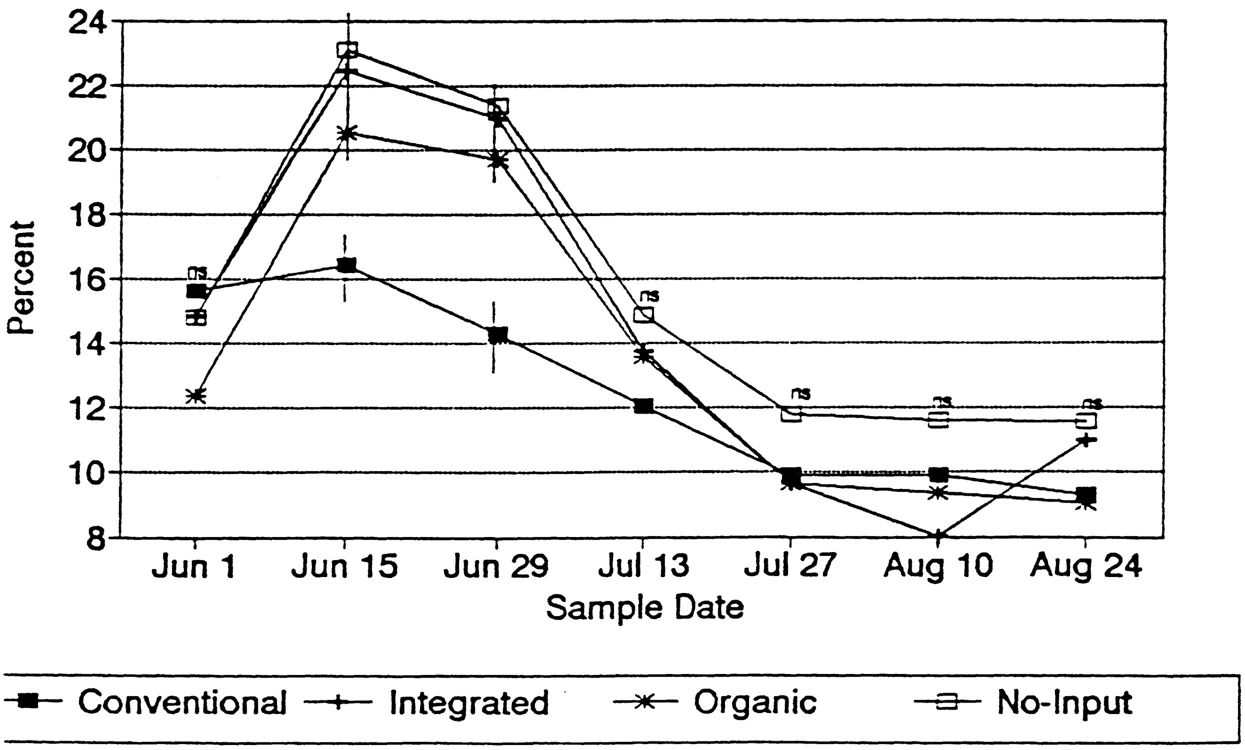
The fact that the organic plots had no disease incidence is encouraging, and the ability of the mulch to reduce soil splashing onto leaves most likely plays a role in this. Additional data from other years and locations will determine if reduced disease incidence will be a consistent benefit of a cover crop mulch.

The soils in this experiment have been conventionally farmed for many years, and are depleted in organic matter and have poor soil structure. After 4 or 5 years of a cover crop/vegetable production system, and resultant soil improvement, tomato yields may further increase.

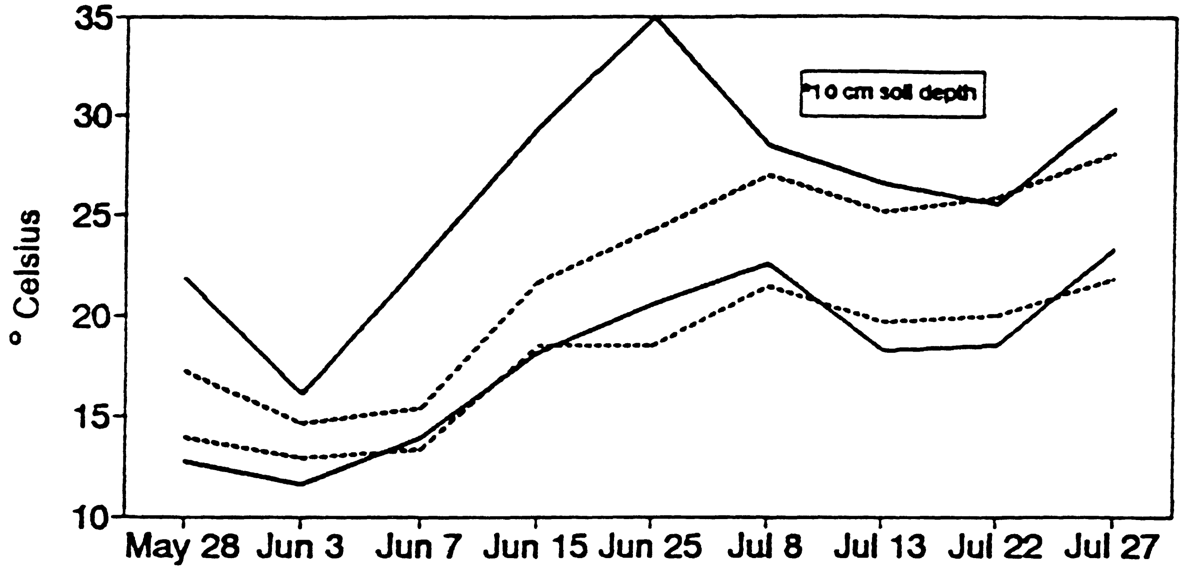
Percent Soil Moisture
Columbus



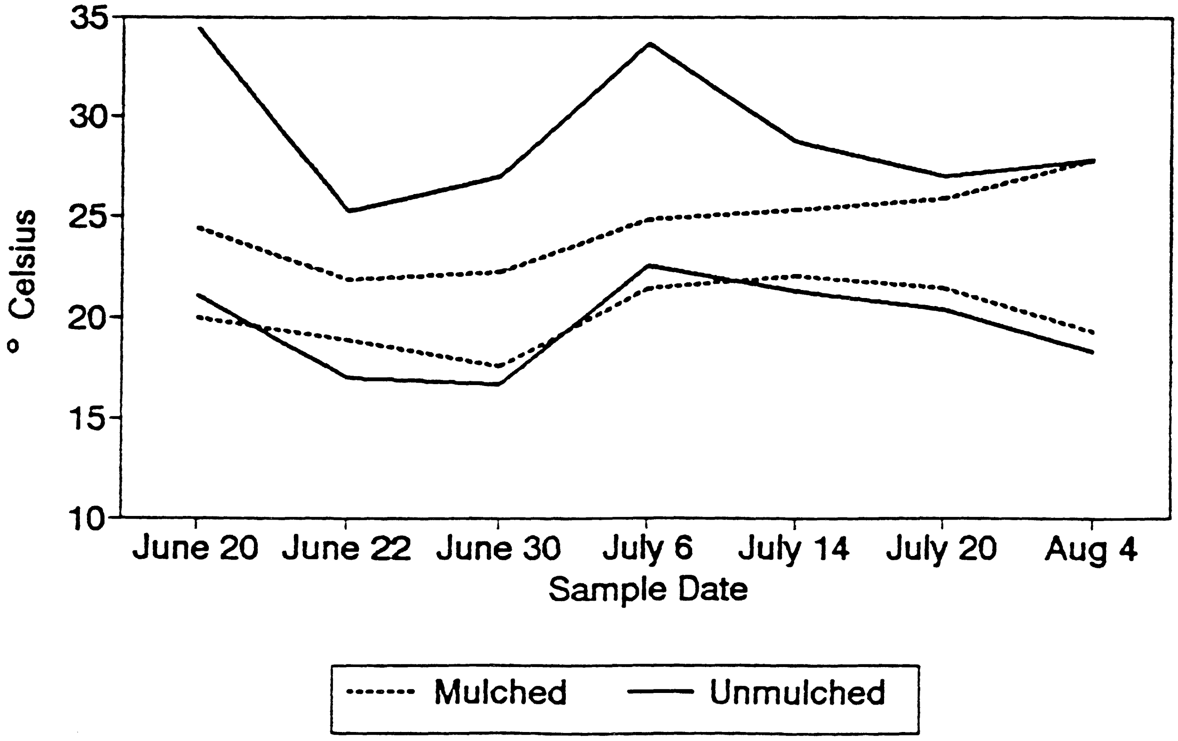
Fremont



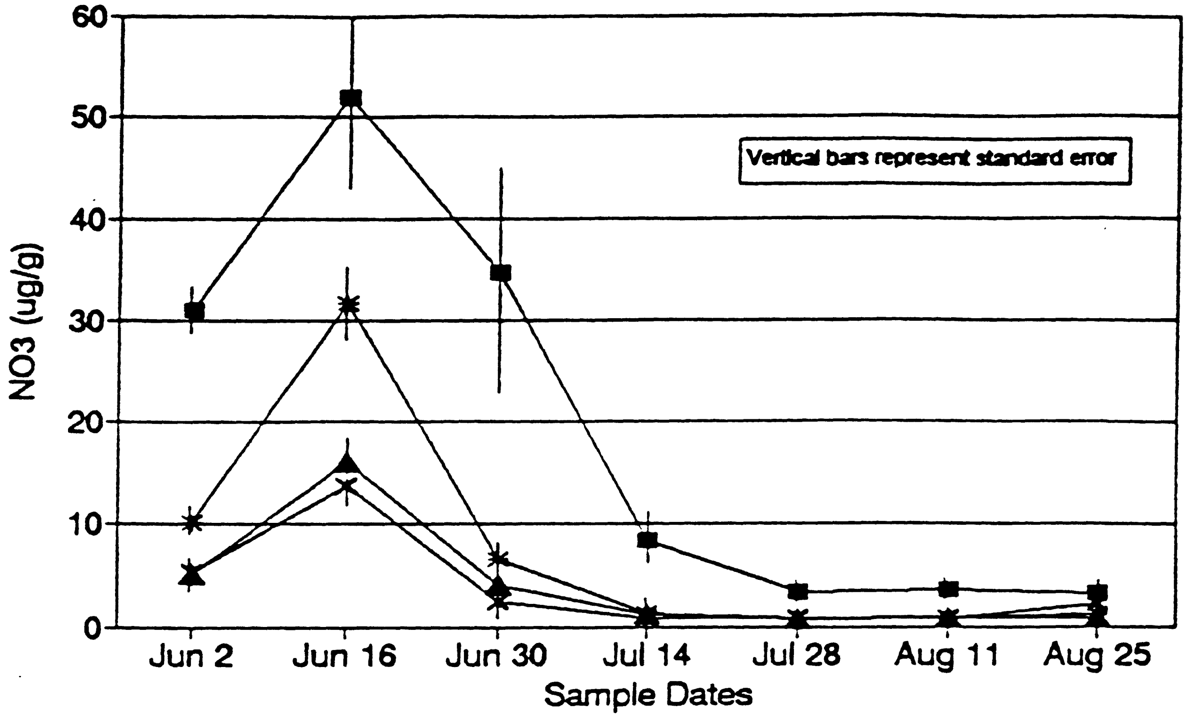
High and Low Soil Temperatures*
Columbus



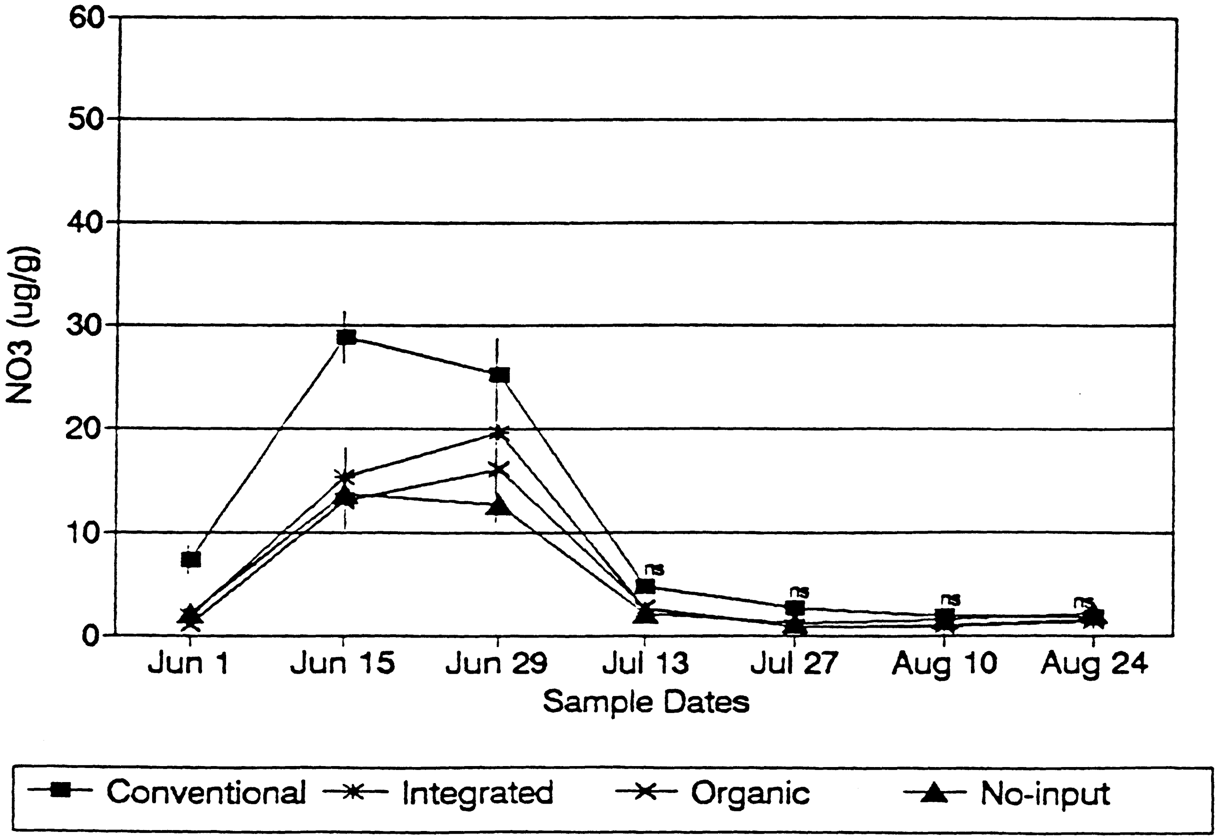
Fremont



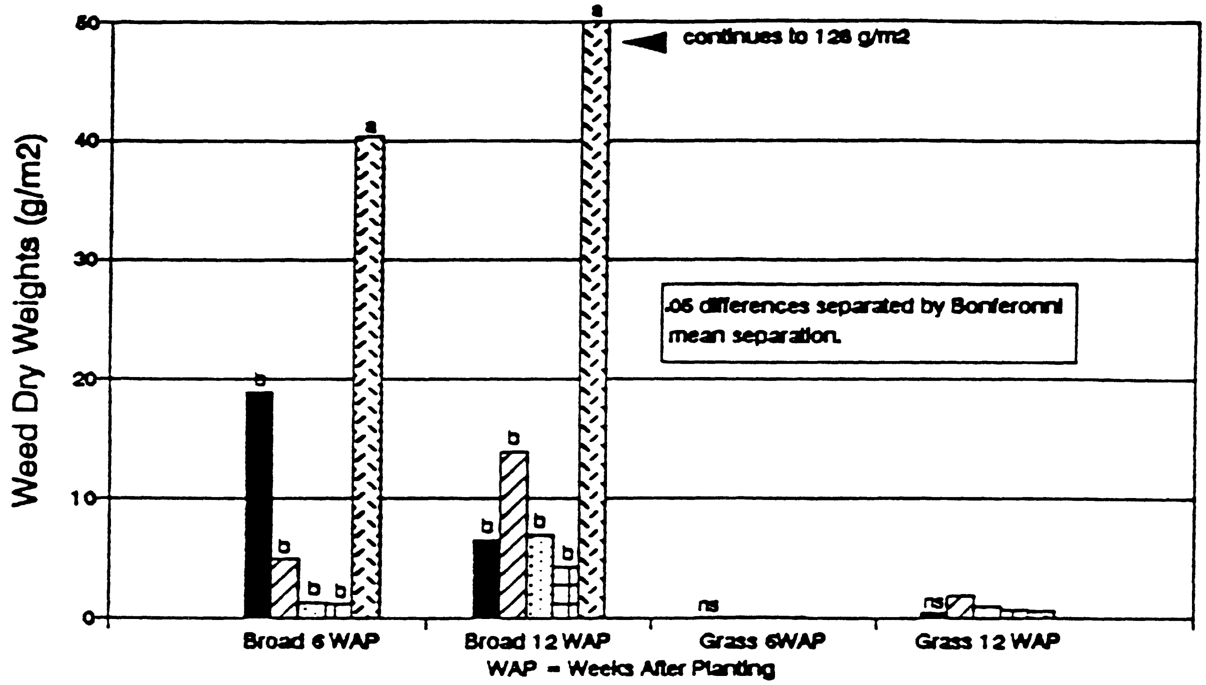
Columbus Soil Nitrate



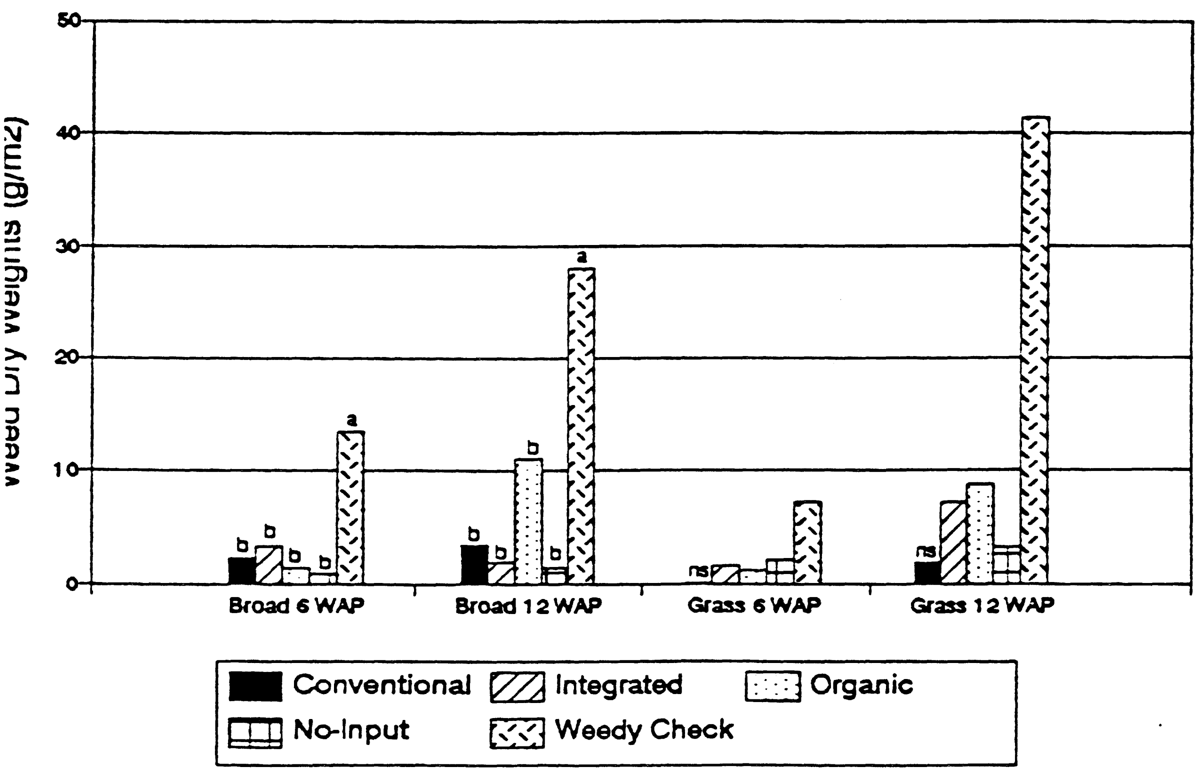
Fremont Soil Nitrate



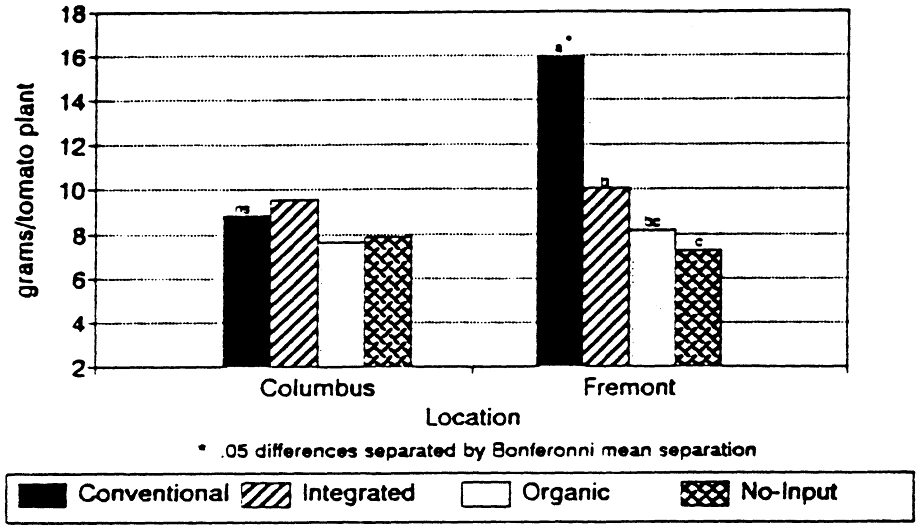
Broadleaves and Grasses 6 and 12 WAP
Columbus



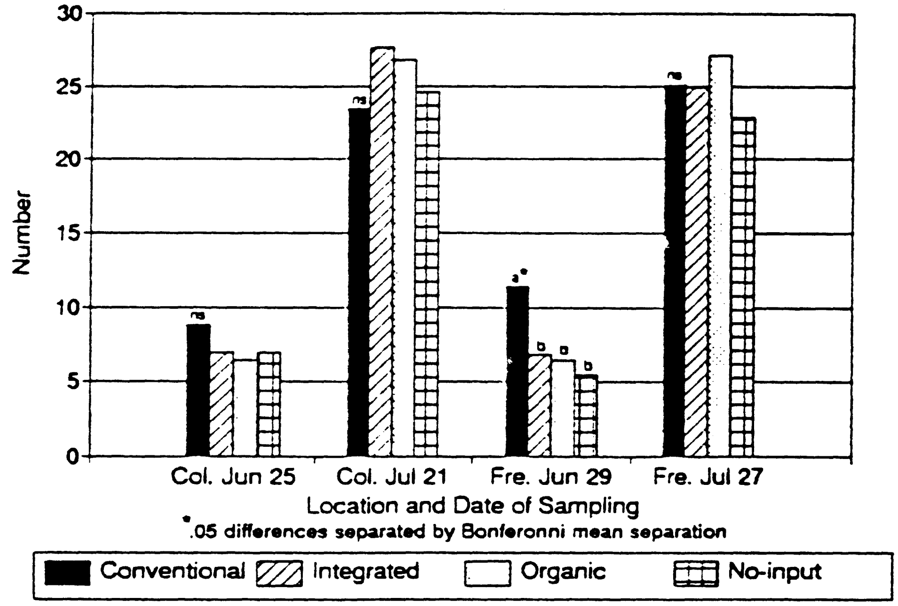
Fremont



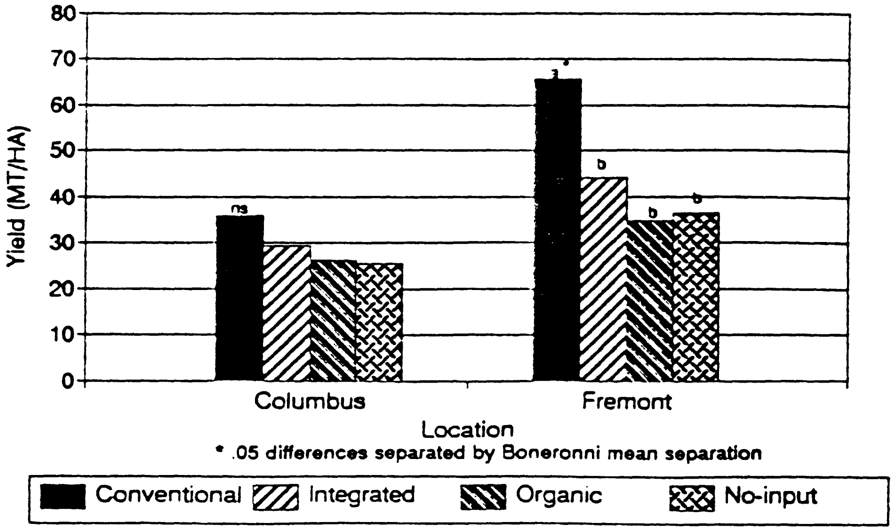
Average Dry Weights
5 weeks after planting



Fruit/Flower Clusters



Yield (MT\HA)
#1 Red Tomatoes



IRRIGATION AND MULCH COMBINATIONS FOR PEPPERS- 1994

Principal Investigators and Key Personnel: Mark Bennett, Elaine Grassbaugh and Mark Schmittgen, Horticulture & Crop Science, and Larry Brown, Agricultural Engineering, Ohio State University, Columbus, OH.

Abstract: Fruit yields for two bell pepper cultivars ('North Star', 'Galaxy') and one jalapeno cultivar ('Mitla') were compared using raised bed production systems ranging from (1) no trickle or mulch, (2) trickle irrigation only, (3) black plastic mulch only, and (4) trickle irrigation plus mulch. Best red fruit yields for 'North Star' (NS) were from mulch, and irrigation + mulch plots (14.4 and 15.7 T/A, respectively), compared to 7.9 T/A from control plots. Total red fruit yields for 'Galaxy' (G) were also best when mulch, and irrigation + mulch systems were used (10.6 and 12.6 T/A, respectively) compared to only 5.4 T/A for control. 'Figaro' was grown as an observation cultivar with drip irrigation and black plastic. Because of later maturity and good uniformity, 'Figaro' needed harvesting only 3 times during the growing season yet red T/A fruit totalled 11.3 and green fruit from the last harvest totalled 7.4 T/A.

Jalapeno yields for irrigation and mulch combinations were not statistically different, but inputs alone or together gave fruit yields of 15.2 to 16.2 T/A, versus 10.9 T/A for bare raised beds. Assuming input costs for $100/A for black plastic mulch, and $150/A for drip tube (KT report, 1993) and receipts of $225/T (red bells) or $400/T jalapenos, plasticulture inputs clearly provided for increased returns under 1994 growing conditions in central Ohio. Average fruit size and percent #1 red fruit was also enhanced by use of plastics (Table 1).

Culture & Management Data:

Soil Type: Kokomo silty clay loam
Fall Plowed: November, 1993
Trickle Lines and Plastic Mulch: May 23, 1994
Peppers Transplanted to the Field: May 24, 25, 1994

Fertilizer
100 lbs N/A 33-0-0 with Vicon spreader and incorporated: May 17
15 lbs N/A 15.5-0-0 applied with Gandy applicator: July 1, 7, 27

Weed Control
2 pts/A Treflan incorporated: May 23
Roundup between plots: June 14; July 7, 13
Hand cultivated: June 14, 28; July 15; Aug. 2

Irrigation
Overhead 1/2" : June 2, 3
Trickle 24 hrs.: June 13
Trickle 17 hrs.: June 17
Trickle 18 hrs.: August 8
Trickle 4 1/2 hrs.: August 18

Irrigation (continued)
Trickle 7 hrs.: August 26
Trickle 14 hrs.: September 13
Trickle 21 hrs.: September 27

Pesticide Applications
MVP 1 1/2 qts/A: July 19
Orthene 1 lb/A + Kocide 2 lbs/A: August 3, 10, 17, 24; September 1, 8, 15.

Discussion and Outlook: Tensiometers (12", 18", and 24") were installed at various locations in the field study to monitor soil moisture levels during the growing season (Figures 1,2). Future studies in this research area will also monitor petiole N levels (NO_3 -N) as additional information on crop status.

TABLE 1. 1994 Pepper Irrigation/Mulch Study
OSU Horticulture Farm, Columbus, OH – Mark Bennett, Larry Brown

Cultivar	Irrigation	Mulch	Red #/A	Red T/A	Reds Avg. wt(lb)	Red #1/A	Red #1 T/A	Red #1 Avg. wt(lb)	Red #2/A	Red #2 T/A	Red #2 Avg. wt(lb)
(Bell Peppers)											
NORTH STAR	NO	NO	60161	7.9	0.23	21722	3.2	0.29	48439	4.8	0.20
	YES	NO	73065	9.8	0.27	32641	5.2	0.32	40424	4.5	0.22
	NO	YES	112210	14.4	0.26	50994	8.1	0.32	61216	6.3	0.21
	YES	YES	113604	15.7	0.28	61216	10.2	0.33	52388	5.5	0.21
GALAXY	NO	NO	33106	5.4	0.32	20444	3.9	0.37	12662	1.5	0.24
	YES	NO	46464	8.8	0.38	31131	6.8	0.43	15333	2.0	0.26
	NO	YES	58545	10.6	0.36	39727	8.2	0.41	18818	2.4	0.26
	YES	YES	62146	12.6	0.40	48206	10.6	0.44	13939	2.0	0.29
LSD (0.05)			15681	2.65	0.04	12572.5	2.46	0.03	12611.6	1.2	0.03
p value											
CV											
(Observation):											
FIGARO	YES	YES	59590	11.3	0.38	42863	9.1	0.42	16727	2.1	0.26

(Jalapeno)	Irrigation	Mulch	Number Fruit/A	T/A	Avg. Fruit wt (lb)	# Culls/A	Culls T/A
MITLA	NO	NO	736454	10.9	.030	39726	0.3
	YES	NO	1143827	16.2	.030	48090	0.5
	NO	YES	982597	16.1	.033	41121	0.3
	YES	YES	874684	15.2	.035	18818	0.2
LSD (0.05)			NS	NS	NS	NS	NS
p value			0.294	0.216	0.434	0.137	0.216
CV			28.0	24.4	13.5	44.3	59.4

Harvest dates:
'North Star': Aug. 19; Sept. 6, 19; Oct. 5, 24
'Galaxy': Sept. 6, 19; Oct. 5, 24
'Figaro': Sept. 19; Oct. 5, 24

'Mitla': Aug.8, 18; Sept. 6, 23; Oct. 14

Table 1 (continued)

Cultivar	Irrig/ Mulch	Green #/A	Green T/A	Green Avg. wt(lb)	Green #1/A	Green #1 T/A	Green #1 Avg. wt(lb)	Green #2/A	Green #2 T/A	Green #2 Avg. wt(lb)	Cull #/A	Cull T/A
NORTH STAR	No, No	22187	2.6	0.20	4530	0.7	0.29	17656	1.6	0.18	48787	3.0
	Yes, No	22884	2.3	0.20	2207	0.3	0.32	20676	2.0	0.19	29040	2.4
	No, Yes	34848	3.8	0.22	5808	0.8	0.29	29040	3.0	0.21	27298	2.1
	Yes, Yes	39959	4.3	0.22	8480	1.3	0.31	31479	3.0	0.19	25671	2.0
GALAXY	No, No	32641	4.4	0.27	12661	2.2	0.35	19980	2.1	0.22	32292	2.9
	Yes, No	29969	4.5	0.30	13242	2.5	0.38	16727	2.0	0.24	24510	2.5
	No, Yes	35429	5.3	0.30	17192	3.2	0.38	18237	2.1	0.23	29272	3.0
	Yes, Yes	39494	5.1	0.27	21606	3.2	0.31	17889	1.9	0.22	22535	2.7
LSD (0.05)		6963.1	1.55	NS	5713.3	1.47	NS	6553.7	0.63	0.04	13065.1	NS
p value				0.06			0.55					0.45
CV				22.2			19.8					26.8
(Observation):												
FIGARO		57151	7.4	0.26	22651	3.7	0.33	34500	3.7	0.22	17076	2.1

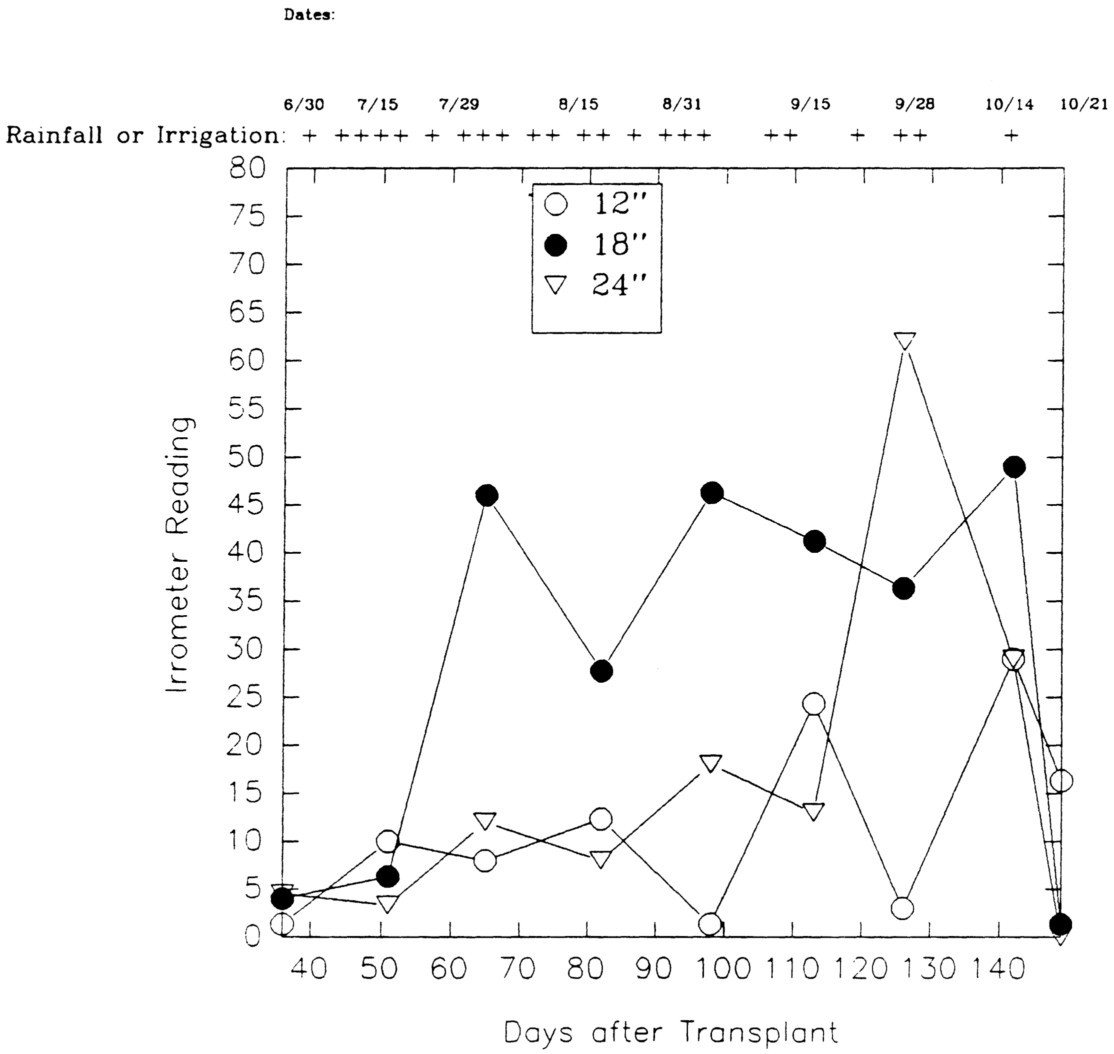


Figure 1. Irrometer readings for drip irrigation only plots, Columbus, OH – 1994.

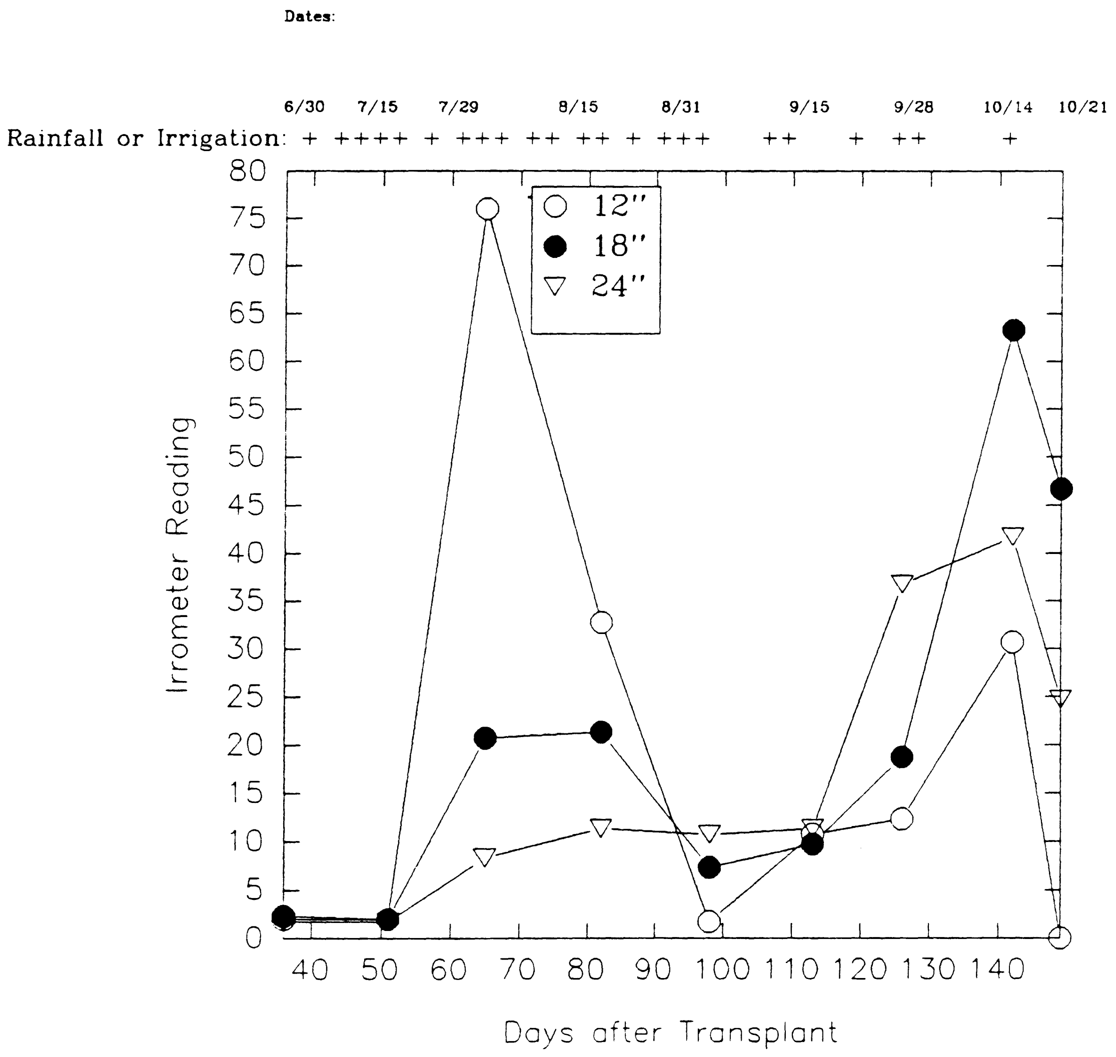


Figure 2. Irrometer readings for mulch + drip irrigation plots, Columbus, OH – 1994.

1994 WEATHER DATA

Vegetable Crops Branch
Fremont, OH

Month	Air Temperature (°F) Average Minimum	Air Temperature (°F) Average Maximum	Rainfall (inches)
April	36.2	61.3	3.95
May	43	69.4	1.02
June	56.6	83	4.12
July	60.7	83.6	1.90
August	53.8	79.2	2.53
September	48.1	77.1	0.94

OSU Horticulture Farm
Columbus, OH

Month	Air Temperature (°F) Average Minimum	Air Temperature (°F) Average Maximum	Rainfall (inches)
April	40.1	65.3	4.19
May	45.7	70.1	2.35
June	58.0	83.2	4.57
July	63.7	85.2	3.79
August	59.0	81.6	3.94
September	42.2	67.8	1.05

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The Ohio State University
Ohio Agricultural Research and Development Center
1680 Madison Avenue
Wooster, Ohio 44691
216-263-3700